

REMARKS

In response to the Examiner's request the references identified in the parent PCT application PCT/JP00/00402, upon which this application is based, shall be submitted to the Patent Office on a separate Information Disclosure Statement as soon as a copy of the references are secured. The cited reference U.S. Patent 5,376,303 is already of record.

In view of the extensive objections to the specification, applicant has filed a substitute specification to correct all of the improper idiomatic expressions and typographical errors pointed out by the Examiner. No new matter has been added to the substitute specification. The claims have also been cancelled and a substitute set of claims added to clarify the invention and the method for producing the light-emitting material. As regards the question of the Examiner in connection with the description of the heating step in the original specification, it clearly provides for successive steps involving forming a mixture of mixture of pulverized raw material, heating the mixture within a specified temperature range under a reduction condition, keeping the temperature constant for another fixed period of time to obtain a sintered body and pulverizing the sintered body following a cooling step. The steps have now been clearly defined and the raw materials defined as selected from a specific group. The heating of the pulverized raw materials occurs at a temperature between 850°C and 1200°C for three hours under a reduction condition. The sintered body is cooled down to room temperature before it is pulverized.

In answer to the Examiner's question regarding the lack of clarity between the two embodiments of it should be understood that:

a) The formula $(\text{Sr, Eu, Dy})_{0.95 \pm X}(\text{Al, B})_2\text{O}_{3.95 \pm X}(\text{Sr, Eu, Dy})_{4-X}(\text{Al, B})_{14}\text{O}_{25-X}$ indicates the resultant and not the raw materials. The resultant is a compound that has a paragenesis crystalline structure consisting of an A-phase which is represented

by $(\text{Sr, Eu, Dy})_{0.95 \pm X}(\text{Al, B})_2\text{O}_{3.95 \pm X}$ and a B-phase which is represented by $(\text{Sr, Eu, Dy})_{4-X}(\text{Al, B})_{14}\text{O}_{25-X}$.

b) When adjusting the ratio of the amount of the element Sr to (Al, B), the ratio of the amount of the A-phase to B-phase can change. Since the amount of SrCO_3 is different in the first embodiment and the second embodiment, the ratio of the A-phase to the B-phase in the resultant of the first embodiment will be different from the resultant of the second embodiment. The subject formula $(\text{Sr, Eu, Dy})_{0.95 \pm X}(\text{Al, B})_2\text{O}_{3.95 \pm X}$ $(\text{Sr, Eu, Dy})_{4-X}(\text{Al, B})_{14}\text{O}_{25-X}$ shows the paragenesis crystalline structure consisting of A-phase $[(\text{Sr, Eu, Dy})_{0.95 \pm X}(\text{Al, B})_2\text{O}_{3.95 \pm X}]$ and B-phase $[(\text{Sr, Eu, Dy})_{4-X}(\text{Al, B})_{14}\text{O}_{25-X}]$. This certainly does not mean that the ratio of the A-phase to B-phase is 1:1. In fact, the ratio of B-phase to A-phase in the first embodiment is bigger than the ratio of the B-phase to A-phase in the second embodiment.

c) Under the identical condition sintering the raw materials having the different ratio of Sr to (Al, B), the sintered body can be described in the subject formula as $(\text{Sr, Eu, Dy})_{0.95 \pm X}(\text{Al, B})_2\text{O}_{3.95 \pm X}$ $(\text{Sr, Eu, Dy})_{4-X}(\text{Al, B})_{14}\text{O}_{25-X}$. The ratio value of A-phase to B-phase is not necessarily 1:1. A-phase and B-phase are paragenesis together and are crystallized from the same sintered body. The A-phase cannot be separated from the resultant and the B-phase cannot be separated from the resultant.

d) The main peak of the light-emitting spectrum of the A-phase is 520nm. The main peak of the light-emitting spectrum of the B-phase is 490nm. The properties of the compound of the present invention are decided by the paragenesis crystalline structure consisting of an A-phase and B-phase. Therefore, the main peak of light-emitting spectrum of the compound is 505nm. Since the compound of the present invention has a paragenesis crystalline structure consisting of an A-phase and B-phase, the compound is different from any compound of the prior art.

e) When the ratio of metal cation in the raw material such as SrCO_3 , Eu_2O_3 , Dy_2O_3 is changed, the ratio of A-phase to B-phase in the resultant is

correspondingly changed. This changes the results causing different optical properties for the resultant. Since the amount of raw materials such as SrCO_3 , Eu_2O_3 , Dy_2O_3 are increased in the second embodiment, the metal cations such as Sr^{2+} , Eu^{3+} , Dy^{3+} are increased. Increasing the metal cations results in increasing the content of the A-phase and decreasing the content of the B-phase in the resultant.

In summary, a different ratio of the same raw materials can be expressed by the formula of the present invention. The results are manufactured using the same raw materials under identical conditions, but the resultants have different optical properties due to the different ratio of the A-phase and the B-phase.

Hopefully the above clarifies the lack of understanding of the Examiner relative to the reference of two embodiments having the same formula with different amounts of raw material.

On page 2 of the Office Action, the Examiner appears to be confused as to how the application indicates that the disclosed material has an afterglow time of 80 hours or more based upon Table 1 which measures the afterglow time from 5 seconds to 48 minutes or 8 hours. As explained in the specification, the light-emitting material of the present invention showed a brightness of about 8500mcd/m^2 after 5 seconds from the instant that the irradiation was stopped and has a visible afterglow time of 80 hours or longer. The brightness at the 480th minute after stopping the irradiation is more than 10mcd/m^2 and it would thus take about 80 hours to decay down to 3mcd/m^2 . One skilled in the art knows that the decay of energy for computing the brightness of a light-emitting material has the following formula: " $I_t = I_0 t^{-n}$ ", where n is the constant of the decay time, and, I_0 is the initial value of the brightness. (When t equals to 5s, we use in practice a value for I_0 that is 8430mcd/m^2 .)

When $t=28800\text{s}$, $I_{28800}=10\text{mcd/m}^2$, and, we can compute the constant of the decay time according to the formula. The constant of decay time is 0.66 but can vary in a range of from 0.6 to 0.75. Since the minimum visible brightness is 3mcd/m^2 , if the

constant of the decay time is 0.66, then according to the formula, we can then compute the decay time that is 86 hours. Based on the computation described above, the specification shows “the visible afterglow time was 80 hours or longer”.

A logarithmic curve is attached which shows the relationship between brightness and time. This is well known to those skilled in the art.

The constant of decay time for the prior art USP 5,376,303 is in a range from 0.94 to 0.86.

The Examiner has also questioned how the average brightness and standard deviations were determined in Table 1. The standard deviation in Table 1 can be explained as follows:

When $t=5s$,

The brightness of Sample No. 1 is 8400mcd/m^2

The brightness of Sample No. 2 is 8450mcd/m^2

The brightness of Sample No. 3 is 8400mcd/m^2

The brightness of Sample No. 4 is 8500mcd/m^2

The brightness of Sample No. 5 is 8430mcd/m^2

So, the Average value of the

$$\text{brightness} = (8400 + 8450 + 8400 + 8500 + 8430)\text{mcd/m}^2 / 5$$

$$= 8430\text{mcd/m}^2$$

According to the standard deviation formula the standard deviation = square root of $[(a-\bar{a})^2 + (b-\bar{a})^2 + (c-\bar{a})^2 + \dots + (n-\bar{a})^2] / n$ + rectified value = square root of $[(8400-8430)^2 + (8450-8430)^2 + (8400-8430)^2 + (8500-8430)^2 + (8430-8430)^2] / 5 = 45$

Using the Relative standard deviation formula as follows:

Relative standard deviation= square root of $[(a-\bar{a})^2+(b-\bar{a})^2+(c-\bar{a})^2+.....+(n-\bar{a})^2]/n^2$ + rectified value

= Square root of $[(8400-8430)^2+(8450-8430)^2+(8400-8430)^2+(8500-8430)^2+(8430-8430)^2]/5 \times 8430^2+0.03\%$

=0.5%

The values of standard deviation and relative standard deviation in table 1 are calculated in the same way.

Regarding the Examiner's questions concerning the formula, "(Sr, Eu, Dy)_{0.95±X}(Al, B)_{2O_{3.95±X}}·(Sr, Eu, Dy)_{4-X}(Al, B)_{14O_{25-X}}", it should be understood that:

The dot "·" in the formula (Sr, Eu, Dy)_{0.95±X}(Al, B)_{2O_{3.95±X}}·(Sr, Eu, Dy)_{4-X}(Al, B)_{14O_{25-X}} only indicates a paragenesis crystalline structure consisting of an A phase and a B phase. It does not indicate that the ratio of the A phase to the B phase is equal. The formula (Sr, Eu, Dy)_{0.95±X}(Al, B)_{2O_{3.95±X}}·(Sr, Eu, Dy)_{4-X}(Al, B)_{14O_{25-X}} is representative of the chemical structure. In the formula (Sr, Eu, Dy)_{0.95±X}(Al, B)_{2O_{3.95±X}}·(Sr, Eu, Dy)_{4-X}(Al, B)_{14O_{25-X}}, (Sr, Eu, Dy)_{0.95±X}(Al, B)_{2O_{3.95±X}} represents A-phase and (Sr, Eu, Dy)_{4-X}(Al, B)_{14O_{25-X}} represents B-phase. The A-phase does not form the B-phase and conversely the B phase does not form the A phase. The two phases form two different kinds of crystalline which together are paragenesis and are simultaneously crystallized from the same sintered body. The invented compound has a large number of micro-multiple crystals each consisting of A-phase (Sr, Eu, Dy)_{0.95±X}(Al, B)_{2O_{3.95±X}} and B-phase (Sr, Eu, Dy)_{4-X}(Al, B)_{14O_{25-X}}. Both A-phase and B-phase can not be separated from the micro-multiple crystals. Use of a microscope shows that the B-phase occupies about 8-12% of the total area in one product of the present invention. The micro-multiple crystals can be treated as a unit.

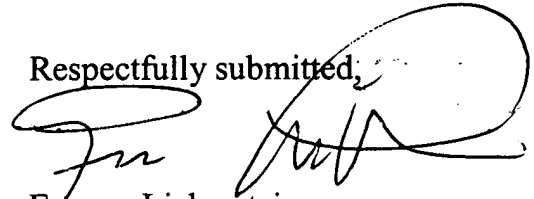
For all of the above reasons, the objection to the disclosure, the specification and the original claims should now be withdrawn. Moreover, the rejection of claim 2 under 35 USC 112, first paragraph, as containing subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventors at the time the application was filed had possession of the claimed invention and that the subject matter of claim 2 is not taught by the specification is respectfully traversed. Although applicant has cancelled original claim 2 and has substituted a new set of claims, claim 11 is substantially identical to claim 2 as originally presented. From the foregoing, it is hoped that the Examiner now has a better understanding of the invention and can clearly understand that the rejection has no merit whatsoever. Withdrawal of the rejection of claim 2, now claim 11, is respectfully solicited.

The rejection of claims 1-9, now claims 10-16, under 35 USC 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention is respectfully traversed.

The amount of the elements B, D_y and E_u in the claimed formula has been clearly set forth with the concentration of B being variable and present between 0.1 and 1.0 % by weight and with the concentration of the elements E_u and D_y varying between 0.5 to 3 % by weight and between 0.1 to 0.3 % by weight respectively. It is obvious to one skilled in the art that this means the average values of each of the elements B, D_y and E_u in the A phase and the B phase respectively. Accordingly, one skilled in the art would have absolutely no problem whatsoever to determine the compound which defines the subject of the present invention and can readily produce the compound from the raw materials in accordance with the method as defined in the present invention. Applicant understands that the Examiner is so totally confused by the present invention that he has had difficulty with understanding the invention and the claims. However, applicant has amended the claims to clarify the invention and has provided a lengthy explanation to assist the Examiner in understanding the invention.

Reconsideration and allowance of new claims 10 to 16 is respectfully solicited.

Respectfully submitted,

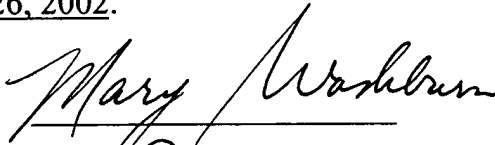


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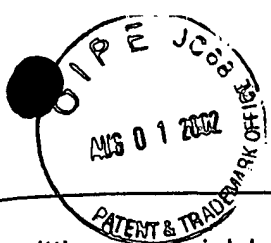
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Date: July 26, 2002

What is claimed is:



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10. (NEW) A light-emitting material having a paragenesis crystalline structure consisting of two different phases expressed by the following general formula:

$(\text{Sr, Eu, Dy})_{0.95 \pm x}(\text{Al, B})_2\text{O}_{3.95 \pm x} \cdot (\text{Sr, Eu, Dy})_{4-x}(\text{Al, B})_{14}\text{O}_{25-x}$ wherein $x=0.01$ to 0.1 , B is present between 0.2 to 1.0% by weight, Eu is present between 0.5 to 3.0% by weight Dy is present between 0.1 to 0.3% by weight.

11. (NEW) A light-emitting material according to claim 10, wherein the element B exists entirely in crystalline form in both of the two phases.

12. (NEW) A method of producing a light-emitting material comprising the steps of:

- (1) pulverizing raw material(s) from the group consisting of SrCO_3 , Al_2O_3 , H_3BO_3 , Eu_2O_3 and Dy_2O_3 ;
- (2) heating the pulverized raw material(s) at a temperature in the range between 850°C and 1200°C for three hours under a reduction condition,
- (3) maintaining the temperature relatively constant at substantially 1200°C to form a sintered body,
- (4) cooling the sintered body down to room temperature, and
- (5) pulverizing the sintered body.

13. (NEW) The method of claim 12 wherein Eu^{3+} of Eu_2O_3 is reduced to Eu^{2+} during sintering.

14. (NEW) The method of claim 12, wherein in step (2), the reduction is carried out using carbon powder.

15. (NEW) The method of claim 13 wherein in step (2), the reduction is carried out using carbon powder.

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16. (NEW) The method of claim 12 wherein the temperature in step (3) was maintained for 5 to 6 hours.

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